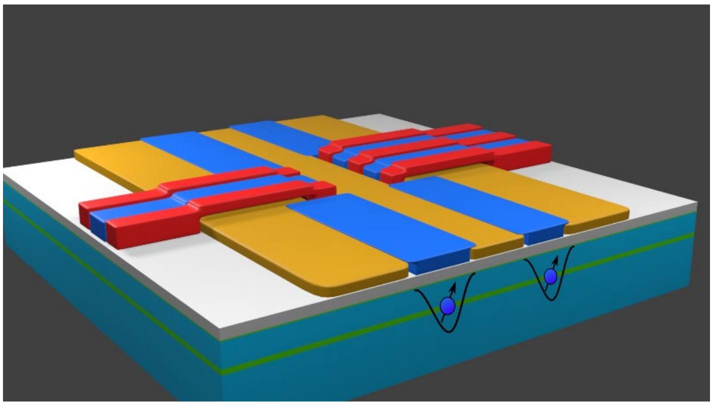
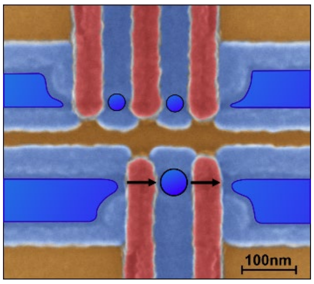
Hector Fellow Academy

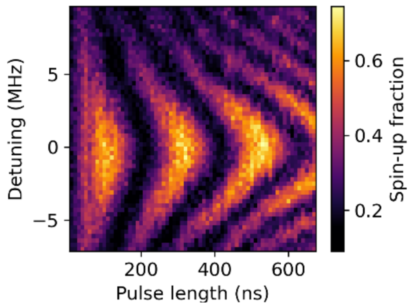
Optimizing the spin qubit control in novel industrial semiconductor spin qubit devices

Project description:

Why is universal quantum computing still out of reach – despite its revolutionizing potential e.g. in chemistry, medicine and cryptography? While high-fidelity operations of single- and multi-qubit gates have been demonstrated across various physical qubit platforms, achieving universally useful quantum processors requires the integration and control of millions of qubits. This scalability challenge is one of the biggest technological hurdles of the 21st century.







Industrial semiconductor manufacturing has already reached the capability to produce classical processors with billions to trillions of transistors. Interestingly, qubits in semiconductor quantum dot devices share many similarities with classical transistor structures. Leveraging industrial fabrication techniques to produce large-scale semiconductor spin qubit processors makes the semiconductor qubit platform one of the most promising candidates for realizing universal quantum computing.

In collaboration with the Interuniversity Microelectronics Centre (imec) in Belgium, we have successfully demonstrated first qubit operations in a device fully fabricated using industrial techniques [1]. Building on this, the next phase involves fabricating and studying larger-scale qubit devices, with a focus on developing and refining strategies for scaling up these qubit devices.

As part of this project, you will utilize an optimized and fast dilution refrigerator to study and characterize spin qubits in semiconductor heterostructures. Your work will include the optimization of qubit control and readout schemes, and contributing to the design of advanced architectures that pave the way for large scale semiconductor-based quantum processors.

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References:

[1] T. Koch et al., Industrial 300 mm wafer processed spin qubits in natural silicon/silicon-germanium, *arXiv*. https://arxiv.org/abs/2409. (2023)

Keywords
Quantum computing
Semiconductor qubit
Spin qubit

Entry requirements
Master degree in Physics

Location
Institute of quantum materials and technology, Karlsruhe Institute of technology, Karlsuhe

Starting date
As soon as possible

Funding

Four years of funding (3+1, three years with the possibility to extend for one year)

How to apply

Please apply via the HFA application portal.

The Hector Fellows will arrange interviews (via skype or if feasible in-person) with the most promising applicants. The final candidates will be invited for an online presentation on June 26, 2025. The final decisions will be announced in July 2025.

Application Deadline
March 31, 2025

Enquiries
For questions related to making your application, please contact Hector Fellow Academy Office: application@hector-fellow-academy.de or www.hector-fellow-academy.de